

# Hunger and health among undocumented Mexican migrants in a US urban area

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## Abstract

*Objectives:* To measure the occurrence and correlates of hunger and to evaluate the association between hunger and three health indicators among undocumented Mexican immigrants.

*Design:* Non-probability cross-sectional sample.

*Setting:* Neighbourhoods within New York City.

*Subjects:* Four hundred and thirty-one undocumented Mexican immigrants living in the USA.

*Results:* Hunger was indicated by approximately 28% of respondents. In a multivariate model, working as a day labourer was associated with hunger (odds ratio (OR) 3.33, 95% confidence interval (CI) 1.83–6.06) while receiving public assistance protected against hunger (OR 0.23, 95% CI 0.06–0.88). In multivariate models, respondents who reported experiencing hunger also reported poorer overall health (OR 1.69, 95% CI 0.95–3.02) and more days of poor mental ( $P = 0.045$ ) and physical health ( $P < 0.0001$ ). Greater amount of time lived in the USA was also associated with worse overall health ( $P = 0.054$ ) and more days of poor mental and physical health ( $P < 0.01$ ).

*Conclusions:* The present study shows that food insecurity and hunger may be problems among undocumented migrants living in the USA. Uncertain and unpredictable work schedules and limited access to public assistance may contribute to high levels of hunger, which in turn may also negatively affect mental and physical health. Increasing amount of time lived in the USA is also associated with poorer health indicators. Programmes that provide undocumented migrants with emergency access to resources may reduce food insecurity and lead to improved health outcomes among this vulnerable population.

**Keywords**  
Food insecurity  
Immigrants  
Food insufficiency  
Acculturation

Food insecurity and its more severe form, hunger, are emerging as important indicators of overall health and well-being in low-income populations<sup>1</sup>. Food insecurity (uncertain access at all times to culturally appropriate foods) occurs in approximately 11% of US households and hunger (discomfort or pain caused by involuntary lack of food) occurs in 3–4% of US households<sup>2</sup>. The prevalence and severity of food insecurity and hunger are driven primarily by inadequate income, but other social, cultural and economic variables are important in structuring an individual's risk of experiencing food insecurity<sup>3</sup>. Regardless of the contributory variables, insecure access to food is known to be associated with a wide range of outcomes related to health and well-being, including poor physical health<sup>4</sup> and mental health and behavioural outcomes among women and children<sup>5,6</sup>.

As such, the prevalence of food insecurity and hunger in a population may be a good indicator of population health, and represents a risk factor for multiple risks. Indeed, studies among low-income populations and migrant populations have generally shown levels of food insecurity and hunger that surpass the national average<sup>2,7–10</sup>, suggesting that uncertain access to food may contribute to the social production of health inequalities.

The foreign-born population living in the USA is currently estimated to be 37 million, of which approximately 11.1 million are undocumented migrants<sup>11</sup>. As the number of foreign-born individuals in the USA has increased so too has public interest in understanding the health and well-being of these persons. Much of this focus has been on diseases that immigrants may be bringing with them

from their home countries<sup>12</sup> or on access and utilisation of health services<sup>13</sup>, with less interest focused on broader determinants of the health of individuals once in the USA. Studies specifically examining issues of food insecurity and hunger among legal migrants have reported alarmingly high rates<sup>10</sup>; however, the prevalence and correlates of hunger among the growing population of undocumented migrants living in the USA have not been previously examined.

Despite the lack of information on the prevalence of hunger among undocumented migrants, we expect undocumented migrants living in the USA to be at even higher risk of experiencing the conditions that promote food deprivation than legal migrants and other low-income populations, and less able than legal migrants to access health care to mitigate the adverse health impacts of hunger. Formal mechanisms designed to safeguard individuals from food insecurity and hunger are unlikely to be accessible to undocumented migrants. This may be institutionalised<sup>10,14</sup> or due to fear on the part of migrants to present for these services (see e.g. reference 15). For instance, undocumented migrants may be excluded from various social services which act as safety nets for citizens and to some extent for documented migrants. Undocumented migrants may also be at an economic disadvantage in the labour market which may be exacerbated by limited education and language barriers. Further, unpredictable or seasonal work may lead to highly variable and unpredictable financial security which may promote food insecurity and hunger. Finally, low levels of acculturation may influence one's ability to access social services, influence shopping practices, and may promote remitting which may further undercut financial security<sup>17</sup>. The objectives of the present study were therefore to: (1) estimate the prevalence of hunger in a sample of undocumented Mexican migrants; (2) examine the extent to which social, economic and cultural variables are associated with the experience of hunger; and (3) assess whether hunger is associated with poor health.

## Methods

The sampling frame consisted of adults (age 18 years or older) from all five boroughs of New York City (NYC) who reported being born in Mexico. Participants were recruited from venues throughout NYC in communities with large populations of Mexican migrants. Venues were selected using a two-step procedure. First, the 12 neighbourhoods in NYC with the highest concentrations of Mexican migrants were identified using US Census data. The neighbourhoods selected were: Sunset Park, East Harlem, North Corona, Elmhurst, Jackson Heights, Astoria, Bushwick, Williamsburg, South Bronx, Chelsea, Lower East Side and Port Richmond. Second, we con-

ducted at least two systematic walk-throughs of all streets in each of the 12 neighbourhoods on different days and at different times of day to identify intra-neighbourhood venues with heavy volumes of foot traffic that would be amenable to conducting interviews. Outreach workers trained in the data collection requirements of the study recruited potential participants between 8 October 2004 and 5 December 2004 using street outreach techniques common in research involving immigrant populations<sup>17</sup>. Briefly, outreach workers positioned at venues solicited participation by distributing fliers describing the study and engaging potential participants in conversations about the objectives, the inclusion criteria, and the voluntary nature of the study.

Participants were eligible for the study if they were 18 years of age or older, self-reported to be Mexican, were not born in the USA and were current residents of NYC. Interested individuals then returned to be interviewed. Interviews were conducted in either English or Spanish by trained and supervised interviewers using translated and back-translated structured questionnaires. On average, it took approximately 20 minutes to administer the questionnaire. The Institutional Review Board at the New York Academy of Medicine approved the study and all study subjects provided oral consent at the time of the interview. In order to preserve the participants' anonymity, no identifying information was collected about them.

In addition to standard sociodemographic information (e.g. age, gender, marital status, education, total income (taxed and untaxed), work type, social support), information was collected from each respondent on the date of entry into the USA, use of public assistance in the USA, and levels of social and linguistic acculturation. Respondents were also asked whether they had experienced hunger and about their self-perceived health. Each individual also noted whether they were a naturalised citizen of the USA or a legal resident, and responses to these questions were used to identify undocumented migrants. Acculturation levels were assessed using a modified version of the Welfare Reform Baseline Interview acculturation module, based on a scale developed for use among Hispanic populations<sup>18</sup>. Linguistic acculturation was assessed using a seven-item scale that asked about the preference for other languages compared with English in a variety of contexts (e.g. what was the language you used as a child, in which language do you usually speak with friends). Social acculturation was assessed using a four-item scale that asked about preference for Mexican, Latino or Hispanic groups as compared with other groups in a variety of social contexts (e.g. your close friends are..., you prefer to go to social gatherings/parties where people are...) and both scales had an acceptable Cronbach's alpha coefficient (>0.90). Responses to these scales were divided into tertiles representing high, medium and low acculturation. In addition to formal

social support (e.g. use of public assistance programmes), we also asked about informal social support, work patterns, and whether respondents sent money to people in their home country (i.e. remittances). Because a growing number of studies with immigrants have documented time-dependent health effects, we also included time lived in the USA as a predictor of food insecurity and the health outcomes. This was broken down into arrival between: 1978 and 1991, 1992 and 1996, 1997 and 1999, 2000 and 2001, and after 2001.

Our primary predictor variable, hunger, was defined as periods of time when respondents experienced hunger but were unable to afford more food. Although the use of the term 'hunger' has recently been criticised<sup>19</sup>, we use this term because the question asked specifically about the experience of hunger. Hunger was measured with a single item, and respondents were asked whether they had experienced periods in the last six months when they were hungry but were unable to eat because they could not afford enough food. Although there is substantial debate in the literature over how to best measure food insecurity<sup>19</sup>, several studies have shown that single-item measures of food insufficiency and hunger have high face validity and are predictive of dietary, mental and physical health outcomes<sup>19–24</sup>. The terms 'food insecurity', 'food insufficiency', 'hunger' and 'severe food insecurity' are conceptually similar. Food insecurity can refer to periods of worry and concern over the food supply, and an individual can experience food insecurity while having sufficient dietary intake. Food insufficiency, hunger and severe food insecurity are encompassed within the construct of food insecurity but refer to periods of time when individuals have involuntarily experienced reductions in dietary intake because they do not have the resources to access enough food or access to culturally appropriate or desired foods. Thus, a respondent may be food-insecure but not hungry but the reverse is not possible. In an attempt to reduce respondent burden we elected to use only a single-item measure of hunger, although we recognise that this is a limitation of the study.

Health was measured in three ways. First, respondents were asked how they would rate their health overall. Possible responses to this question were: excellent, very good, good, fair or poor. Responses were dichotomised for analysis; those who reported fair or poor health were grouped together, while those who reported good, very good or excellent health were grouped and assumed to have 'good health'. Second, respondents were asked about their physical health. Specifically, they were asked to think about their physical health in the last 30 days and self-assess on how many days in the last 30 they regarded their health as 'not good'. Third, respondents were asked about their mental health, again using the number of days in the last 30 that their mental health was 'not good' as the health indicator of interest. The measures of mental and

physical health were entered as continuous variables. These measures of health have proven validity and reliability<sup>25,26</sup> and are utilised in other widely used questionnaires (e.g. Behavioral Risk Factor Surveillance System questions<sup>27</sup>, National Health and Nutrition Examination Survey<sup>28</sup>).

We calculated the proportion of respondents who provided an affirmative response to the hunger question. We used Spearman's correlation and the  $\chi^2$  test to examine bivariate associations between selected covariates. Next, we used multivariate logistic regression and ordinary least squares regression models to identify (1) factors independently associated with hunger and (2) whether the experience of hunger was associated with health indicators after adjusting for potential confounders. Covariates included in the models are shown in Table 1. The 0.05 level was chosen as the criterion for statistical significance and *P*-values less than 0.10 were flagged as marginally significant. SAS software version 9.1 (SAS Institute) was used for all statistical analyses.

## Results

### *Sample characteristics*

Selected characteristics of the sample are shown in Table 1. The results reported here include 431 individuals of self-reported undocumented immigration status. Mean age of the sample was 32 years (standard deviation 9.0, minimum 18, maximum 80), and approximately 70% of participants were male. Half of the sample reported their marital status as married, 41% reported being single, and 8% reported being divorced or living in another relationship arrangement. A majority of the sample (65%) had lived in the USA for less than 10 years, and 85% reported sending remittances back to family or friends in their home country. Educational achievement was overall quite low: 83% of respondents reported less than a high school education, 10% reported high school or equivalent, and 7% reported at least some college. Respondents' income was categorised into 'legal' and 'off the books'. For 'legal' income, no income was reported by 57% of respondents, 16% of respondents reported earnings between \$1 and \$9999, and 12% reported yearly earnings of more than \$10 000. Missing responses were evident for 15% of respondents. For 'off-the-books' or untaxed income, 26% reported no income, 31% reported earnings between \$1 and \$9999, and 21% reported earning more than \$10 000. Roughly 22% of responses were missing. Day labour carried out in the last six months was reported by 24% of respondents.

More than a quarter of the sample reported experiencing hunger (28%). In bivariate analyses (Table 2), hunger was associated with legal (*P* = 0.032) and off-the-books income although the latter not in a clear dose-response fashion (*P* = 0.012). Men (*P* = 0.027), those having

**Table 1** Selected characteristics of the study sample

Variable	<i>n</i>	%
Legal income		
No income	245	57.0
\$1–\$9999	70	16.3
>\$10 000	51	11.9
Missing	64	14.9
Off-the-books/untaxed income		
No income	112	26.1
\$1–\$9999	134	31.2
>\$10 000	91	21.2
Missing	93	21.6
Age category (years)		
18–24	104	24.2
25–34	176	41.0
35–44	112	26.1
>44	37	8.6
Gender		
Male	298	69.6
Female	130	30.4
Marital status		
Single	176	40.9
Married	218	50.7
Divorced	9	2.1
Other	27	6.3
Year entered the USA		
1991 or earlier	78	18.7
Between 1992 and 1996	64	15.4
Between 1997 and 1999	88	21.1
Between 2000 and 2001	79	18.9
After 2001	108	25.9
Worked as day labourer (in past six months)		
Yes	103	23.9
No	327	76.1
Social support		
Low	187	45.8
Medium	153	37.5
High	68	16.7
Received money from public assistance (in past six months)		
Yes	39	9.1
No	391	90.9
Send money to family/friends in home country		
No	64	14.9
Yes	365	85.1
Education (highest level completed)		
Less than high school	358	83.3
High school or GED	43	10
At least some college	29	6.7
Linguistic acculturation/preference		
Lowest level of acculturation	106	26.9
Moderate level of acculturation	159	40.4
Highest level of acculturation	129	32.7
Social acculturation/preference		
Lowest level of acculturation	172	43.8
Moderate level of acculturation	106	27.0
Highest level of acculturation	115	29.3
Experienced hunger in last six months		
Yes	120	28.0
No	309	72.0

GED – General Education Development Certificate.

worked as a day labourer in the past six months ( $P < 0.0001$ ) and individuals who had not received any public assistance in the previous six months ( $P = 0.010$ ) were more likely to report experiencing hunger. Those who reported sending money to friends and family in one's home country were also more likely to have

**Table 2** Bivariate associations between the experience of hunger and selected social and economic factors

Outcome	% Hunger	<i>P</i> -value
Legal income		0.032
No income	32.7	
\$1–\$9999	22.9	
>\$10 000	13.7	
Missing	26.6	
Off-the-books/untaxed income		0.012
No income	20.5	
\$1–\$9999	37.3	
>\$10 000	29.7	
Missing	21.5	
Age category (years)		0.601
18–24	24.0	
25–34	27.3	
35–44	32.1	
>44	29.7	
Gender		0.027
Male	31.2	
Female	20.8	
Marital status		0.708
Single	26.7	
Married	28.0	
Divorced	44.4	
Other	29.6	
Year entered the USA		0.568
1991 or earlier	21.8	
Between 1992 and 1996	31.3	
Between 1997 and 1999	27.3	
Between 2000 and 2001	30.4	
After 2001	32.4	
Worked as day labourer (in past six months)		<.0001
Yes	48.5	
No	21.4	
Social support		0.566
Low	30.5	
Medium	26.1	
High	25.0	
Received money from public assistance (in past six months)		0.010
Yes	10.3	
No	29.7	
Send money to family/friends in home country		0.037
No	17.2	
Yes	29.9	
Education (highest level completed)		0.607
Less than high school	28.8	
High school or GED	25.6	
At least some college	20.7	
Linguistic acculturation/preference		0.061
Lowest level of acculturation	20.8	
Moderate level of acculturation	34.0	
Highest level of acculturation	27.1	
Social acculturation/preference		0.254
Lowest level of acculturation	29.7	
Moderate level of acculturation	32.1	
Highest level of acculturation	22.6	

GED – General Education Development Certificate.

reported hunger ( $P = 0.037$ ). There was some indication that hunger was associated with higher level of linguistic acculturation but this was only marginally significant in bivariate analyses ( $P = 0.061$ ) and there was no association with social acculturation ( $P = 0.254$ ). Income, age, gender, marital status, education and time lived in the USA

**Table 3** Multivariate regression models\* predicting overall health and number of days of mental and physical ill-health

Effect	Poor health†		Days of poor mental health‡			Days of poor physical health‡		
	OR (95% CI)	P-value	$\beta$	SE	P-value	$\beta$	SE	P-value
Hunger	1.69 (0.95–3.02)	0.075	0.39	0.07	0.045	0.96	0.19	<0.0001
Year entered the USA		0.054			0.002			<0.0001
1991 or earlier	1.00 (referent)		1.00	–		1.00	–	
Between 1992 and 1996	0.54 (0.22–1.35)		–0.35	0.251		0.13	0.25	
Between 1997 and 1999	0.41 (0.18–0.95)		–0.13	0.29		–0.99	0.29	
Between 2000 and 2001	0.35 (0.14–0.84)		–0.25	0.39		–0.88	0.29	
After 2001	0.26 (0.11–0.64)		1.00	–		–1.09	0.31	

OR – odds ratio; CI – confidence interval.

\* Models control for 'taxed' and 'untaxed' income, age, education, gender, marital status, work type, social support, receipt of public assistance, remittances, and social and linguistic acculturation.

† Logistic regression analyses.

‡ Linear regression analyses.

were not statistically associated with the occurrence of hunger. Interestingly, social support was also not correlated with the experience of hunger ( $P=0.566$ ). In a multivariate analysis examining independent correlates of hunger, only two variables were associated with hunger: working as a day labourer in the past six months was associated with increased odds of hunger (odds ratio (OR) 3.33, 95% confidence interval (CI) 1.83–6.06) and receiving public assistance in the past six months was protective against hunger (OR 0.23, 95% CI 0.06–0.88). In that model, neither measure of acculturation was associated with hunger, nor were education, remitting behaviour, social support, marital status, gender, age or income.

In bivariate analyses, hunger was associated more days of poor physical health (5.5 vs. 2.4 days,  $P<0.0001$ ), more days of poor mental health (4.7 vs. 3.2 days,  $P=0.052$ ), and somewhat worse reported overall health (35% vs. 28% reporting poor health,  $P=0.145$ ). In multivariate analyses, hunger was independently associated with all three health indicators (Table 3). Respondents reporting hunger were more likely to report overall poor health (OR 1.69, 95% CI 0.95–3.02;  $P=0.075$ ) and reported significantly more days of poor mental health ( $P=0.045$ ) and poor physical health ( $P<0.0001$ ). The only other variable that was consistently associated with the three health outcomes was time lived in the USA. Longer duration in the USA was associated with poorer overall health ( $P=0.054$ ), more days reported with poor mental health ( $P=0.002$ ), and more days of poor physical health ( $P<0.0001$ ). Males reported poorer overall health (OR 2.35, 95% CI 1.08–5.15) but gender was not predictive of the other health outcomes. Marital status, income, work patterns, formal and informal support, remittances, education and acculturation were not predictive of health outcomes in this population. Both linguistic ( $P=0.026$ ) and social acculturation ( $P=0.014$ ) were associated with time in the USA: longer time lived in the USA was associated with greater acculturation.

## Discussion

This is the first study that we know of to examine the prevalence of hunger and its association with various health indicators among undocumented Mexican migrants living in an urban setting in the USA. Twenty-eight per cent of respondents experienced hunger in the six months prior to the survey. The experience of hunger was associated with receipt of public assistance and working as a day labourer. Hunger was also associated with poorer overall health and more days of poor physical and mental health. We also found that longer duration of time lived in the USA was associated with worse health on all three health indicators. No other social or economic variables were consistently associated with the health indicators assessed here.

There are several limitations which should be considered when interpreting these results. First, our measure of hunger does not reflect the full range or severity of food insecurity that may be experienced in this population. Constraints and challenges involved in working with undocumented migrants necessitated us to use a measure that was quick to assess. We therefore used a single measure of hunger whereas other tools that have been designed to measure anxiety and concern over food supply rely on scales with a minimum of six items<sup>29</sup>. This means that respondents in our study had fewer opportunities to provide responses indicative of food insecurity. The estimate of the occurrence of hunger among this population, therefore, is most likely a considerable underestimate of the true prevalence of food insecurity. Because we did not use a commonly employed measure of food insecurity or hunger our results are not directly comparable with other studies. It is worth pointing out, however, that a study of Latino families found that a single-item measure of food insufficiency in the past 12 months was highly correlated with the 18-item US Household Food Security Scale, and both predicted lower household inventories of various foods<sup>9</sup>. Another study of Latino youth found that a single-item measure of food

insufficiency was predicted by household poverty, education level of household head, and other measures of socio-economic status<sup>30</sup>. Although those studies included the measure 'not having enough to eat', future research in undocumented populations should utilise well-established instruments for measuring food insecurity. Second, we also note that this was a cross-sectional study and hence we have no way of determining a causal relationship in the association between hunger and the health indicators. It is equally plausible that those persons with poor self-reported health will also report hunger as it is that those experiencing hunger who will report poor health. The purpose of this study was to document the association between the two constructs; further research will need to identify longitudinal pathways that can guide specific interventions. Third, again of necessity, we did not collect data on all the possible variables that may be associated with health outcomes. As such it may be that hunger is acting as a proxy for limited access to health care. It is noteworthy that studies that have controlled for more covariates do identify an effect of food insecurity or hunger on health outcomes, suggesting that additional covariates are unlikely to drive the relationships between hunger and health observed in this study. A final limitation lies in the sampling strategy used to identify respondents, which disallows us from calculating a response rate. Those individuals who had heard of the study approached interviewers; we cannot know how many people heard of the study but elected not to participate. Nevertheless, it appears as though our sample matches many of the characteristics of the undocumented community. Studies by the Pews Hispanic Center report a male bias among adult members of the undocumented population. Undocumented migrants are likely to have lived in the USA for less than 10 years and to be young (i.e. most adults are less than 45 years old). An additional feature of the undocumented population is low income and low educational attainment<sup>11</sup>. Our sample shares these same characteristics and therefore increases our confidence that our sample is broadly representative of the wider undocumented population.

A limited body of research has documented food insecurity, food insufficiency and hunger among legal migrants, often with a specific focus on Mexican-Americans and Mexican migrants, although rarely in an urban setting. That work has called attention to the high levels of food insecurity, the contribution of the unpredictable nature of seasonal labour, and the potentially protective effects of social assistance programmes like the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) and the federal Food Stamp Program (FSP). A large study of legal migrants living in California, Texas and Illinois reported that 81% of households reported some level of food insecurity, with 41% reporting experiencing food insecurity with hunger or food insufficiency<sup>31</sup>. Independent predictors in that multi-

ethnic study of food insecurity and hunger included low income, receipt of foods stamps, Latino ethnicity and poor English ability. Levels of hunger were also noted to be extraordinarily high (25–50%) in a study of legal immigrants in two large California cities<sup>32</sup>. Quandt *et al.*<sup>33</sup> examined the occurrence of food insecurity and hunger among 102 migrant Latino workers and reported that food insecurity was indicated in 41% of households, being more likely to occur in households with children and among households with lower education attainment. In that study document status was not confirmed, although it was implied that a large portion of the sample may not have had documents and were therefore unable to access social services that may have been useful in mitigating food insecurity. In the current study we found few predictors of hunger beyond engaging in day labour and receiving public assistance. The former is likely associated with hunger because of the low pay as well as the uncertainty and stochastic nature of this work, which leads to a large flux in income and therefore insecure access to food. This finding may also indicate a general inability to locate employment outside the informal sector. The latter finding, that receipt of social services is protective, is consistent with other literature and suggests public assistance is a crucial safety net.

In this study, time spent in the USA was not predictive of a lower likelihood of hunger, which contrasts with other studies of migrants and refugees who have more secure access to public assistance<sup>16,34</sup>. We suspect that the different legal status and rights to access to services explain this association, or lack thereof. Refugees and legal immigrants are eligible for a range of services, including eligibility for participation in the FSP and WIC, both of which are important public health nutrition safety nets<sup>10</sup>. A study of legal immigrants in California demonstrated the importance of public assistance programmes by comparing the prevalence of hunger before and after federally mandated cuts in benefits to legal immigrants. In that study, post-welfare reform levels of hunger were significantly and substantially greater than pre-reform levels, indicating a protective effect of food stamps on secure access to food. Even at reduced levels, documented migrants and refugees are likely to utilise such services with less fear of exposing their legal status, whereas the same is probably not true for a large proportion of undocumented migrants. For instance, some data on health-care usage among undocumented migrants shows that more than a third of individuals reported not seeking appropriate care because of fear of discovery<sup>15</sup>. Even among legal immigrants in the USA there is evidence that public assistance programmes are under-used, in part due to misinformation on available programmes and because of fear that use of services will result in deportation<sup>10</sup>. Thus, we expected use of public assistance to be both limited in this sample and associated with food security; this is precisely what we observed.

Hunger was consistently associated with health indicators in all the models constructed in this study. The robustness of this finding is consistent with an emerging literature in public health nutrition, which suggests a central role for uncertainty and worry over the food supply as well as hunger as a determinant of health<sup>4,21,35,36</sup>. There are four likely explanations for the relationship between hunger and poor health. First, the finding may simply result from the bidirectional nature of the study variables: poor health may predispose to hunger which in turn may further erode health and well-being; more rigorous study designs are needed to assess this possibility. Second, food-insecure and hungry households are likely characterised by unpredictability and uncertainty with respect to other factors such as income that may be essential to meet basic needs. It is likely that this unpredictability and uncertainty contributes to ongoing psychosocial stress that may be an important contributor to several common mental health disorders<sup>37</sup>. Third, food insecurity and hunger are associated with poor dietary intake; in national studies, food-insecure households report consuming fewer fruits and vegetables, and milk products, and have lower intakes of calcium, fibre, potassium, vitamin A and dietary energy<sup>3,35</sup>. Differences in dietary intake may have both short- and long-term health implications. Fourth, hunger may be a proxy for extreme poverty, which may limit access to salutary resources such as insurance. Future studies that distinguish between these hypotheses will be most helpful.

The finding that time lived in the USA is predictive of poorer health indicators is consistent with an emerging literature on the health outcomes of foreign-born individuals living in the USA<sup>12</sup>. Key themes to emerge from that body of work suggest that many immigrants, but not all, experience worsening health outcomes with greater amounts of time in the USA<sup>12,38,39</sup>. Our results also indicate that undocumented immigrants who have lived in the USA for longer periods of time report poorer health outcomes, although it is not yet clear why this is the case. Although it is possible that this finding represents a cohort effect, with the more recent arrivals being healthier, this is not consistent with a more general finding that the healthiest individuals are more likely to migrate first – the so-called ‘healthy migrant effect’. There are few hints in this dataset as to why newcomers might be healthier, although other studies have suggested or pinpointed changing behaviours, increased exposure to poverty, acculturation and discrimination<sup>40,41</sup>.

Our findings have several possible policy implications. First, the finding that hunger is robustly associated with health indicators may suggest that improving food security may be one pathway to improving health among undocumented migrants. Hunger is a modifiable risk factor and interventions and policies that reduce the prevalence of food insufficiency can be quite effective. Perez-Escamilla *et al.*<sup>42</sup>, for instance, reported that food

stamp use was associated with greater food security in an urban sample of low-income households. These results and our own suggest that programmatic changes may be a productive intervention. Implementing programmes to reduce hunger may result in a cascade of benefits including reduced use of emergency services and improved physical and mental outcomes among women and children. Because periods of hunger are often limited in duration and can often be mitigated by access to formal or informal networks, improving access to short-term, emergency funds may be a cost-effective way to improve the health of this population. Along the same lines, our regression results suggest that perhaps limited economic options and the need therefore to engage in uncertain and unpredictable day labour may undermine food security and increase hunger. The implication of our results is that strategies to relax restrictions on employing undocumented migrants may have beneficial impacts on food security and, by association, on mental and physical health outcomes.

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*Authorship responsibilities:* study design – S.G., A.N., G.L., S.S. and D.O.; study implementation – S.G., G.L. and S.S.; data analysis – V.N., S.G. and C.H.; write-up – C.H. and S.G.; critical review of manuscript – S.G., V.N., G.L., D.O. and S.S.

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